Claims

1. A device for modulating light in the visible spectrum comprising

an array of modulation elements, and

control circuitry connected to the array for controlling each of the modulation elements independently,

each of said modulation elements having a surface which is caused to exhibit a predetermined impedance characteristic to particular frequencies of light.

2. The device of claim 1 wherein the surface comprises antennas configured to interact with selected frequencies of light.

3. The device of claim 1 wherein the surface comprises a surface of an interference cavity.

4. The device of claim 1 wherein the impedance characteristic comprises reflection of particular frequencies of light.

5. The device of claim 1 wherein the impedance characteristic comprises transmission of particular frequencies of light.

6. The device of claim 1 wherein each of the modulation elements comprises an interference cavity that is deformable to alter the cavity dimension.

7. The device of claim 6 wherein the interference cavity comprises a pair of cavity walls separated by a cavity dimension.

8. The device of claim 7 wherein the cavity walls comprise two mirrors.

9. The device of claim 8 wherein one of the mirrors comprises a broadband mirror and the other of the mirrors comprises a narrow band mirror.

10. The device of claim 8 wherein both of the mirrors comprise narrow band mirrors.

11. The device of claim 8 wherein both of the mirrors comprise broad band, non-metallic mirrors.

12. The device of claim 6 wherein the cavity dimension renders the cavity resonant with respect to light of the frequency defined by the spectral characteristics of the mirrors and intrinsic cavity spacing in an undeformed state.

13. The device of claim 7 wherein one of the mirrors comprises a hybrid filter.

14. The device of claim 7 wherein one of the walls comprises a dielectric material, a metallic material, or a composite dielectric/metallic material.

15. The device of claim 7 wherein the cavity is deformable by virtue of a wall that is under tensile stress.

16. The device of claim 1 wherein the control circuitry is connected for analog control of the impedance to light of each element.

17. The device of claim 16 wherein each modulation element comprises an interference cavity having a mechanism for varying the cavity dimension.

18. The device of claim 17 wherein the mechanism comprises a deformable wall of the cavity and the control circuitry controls the degree of deformation of the cavity.

19. A device for modulating light in the visible spectrum comprising

an array of modulation elements, and

control circuitry connected to the array for controlling the amplitude of light delivered by each of the modulation elements independently by pulse code modulation.

20. The device of claim 19 comprising a color display having three separate arrays, each optimized for a particular color.

21. The device of claim 19 comprising a color display having one array with three sets of pixels

fabricated on it, each set optimized for a particular color.

22. The device of claim 19 comprising a color display having two arrays, one optimized for the entire visible spectrum which acts as a binary pulse code modulation brightness control while the other is an array of fixed or continuously variable devices used to select specific colors.

23. A device for modulating light in the visible spectrum comprising

a modulation element having a deformable portion, held under tensile stress, and

control circuitry connected to control the deformation of the deformable portion.

24. The device of claim 23 wherein the modulation element is self-supporting.

25. The device of claim 23 wherein the modulation element is held on separate supports.

26. The device of claim 23 wherein the deformable portion comprises a membrane supported along its edges by supports.

27. The device of claim 26 wherein the membrane is generally planar and the supports are attached to at least two opposite edges of the membrane.

28. The device of claim 27 wherein the membrane is rectangular.

29. The device of claim 27 wherein the supports are orthogonal to the membrane.

30. The device of claim 24 further comprising a wall which, with the membrane, forms an interference cavity, and wherein the deformable portion, under one mode of control by the control circuitry, is collapsed onto the wall.

31. The device of claim 24 wherein the control circuitry controls the deformable portion by signals applied to the modulation element, and the deformation of

the control portion is subject to hysteresis with respect to signals applied by the control circuitry.

32. A device for modulating light in the visible spectrum comprising

a deformable modulation element having a deformation mechanism and an optical portion, the deformation mechanism and the optical portion independently imparting to the element respectively a controlled deformation characteristic and a controlled modulation characteristic.

33. The device of claim 32 wherein the deformation mechanism comprises a flexible membrane held in tensile stress, and the optical portion is formed on the flexible membrane.

34. The device of claim 33 wherein the optical portion comprises a mirror.

35. The device of claim 34 wherein the mirror has a narrow band.

36. The device of claim 34 wherein the mirror has a broad band.

37. The device of claim 34 wherein the optical portion comprises a hybrid filter.

38. The device of claim 32 further comprising a wall which, together with the flexible membrane, defines an interference cavity.

39. A device for modulating light in the visible spectrum comprising

a deformable modulation element having a deformation mechanism, the deformable element including a non-metal.

40. The device of claim 39 wherein the deformation element comprises a flexible membrane held in tensile stress.

41. The device of claim 39 wherein the deformation element comprises a mirror.

42. The device of claim 41 wherein the mirror has a narrow band.

43. The device of claim 41 wherein the mirror has a broad band.

44. The device of claim 41 wherein the optical portion comprises a hybrid filter.

45. A process for making cavity-type modulation elements comprising

forming a sandwich of two layers and a sacrificial layer between them, the sacrificial layer having a thickness related to the final cavity dimension, and

using chemical or a plasma based etch process to remove the sacrificial layer.

46. The process of claim 45 wherein the etch process is used to remove the sacrificial layer and ion assisted deposition is used to deposit the structural materials, wherein the resulting process can be used to fabricate any micromachined device which uses a sacrificial layer to support and define a structure until the structure is ready for release which occurs during the final etching of the sacrificial layer.

47. The process of claim 45 wherein the chemical etchant used to remove the sacrificial layer comprises water, and the resulting process is used to fabricate any micromachined device which uses a sacrificial layer to support and define a structure until the structure is ready for release which occurs during the final etching of the sacrificial layer.

48. The device of claim 1 wherein said characteristic comprises reflection of incident electromagnetic radiation in the visible spectrum.

49. The device of claim 48 wherein said characteristic comprises the pr portion of incident electromagnetic radiation of a given frequency band that is, on average, reflected by each of said modulation elements.

50. The device of claim 49 wherein said modulation element is responsive to a particular electrical condition to occupy either a state of higher reflectivity or a state of lower reflectivity, and said control circuitry generates a stream of pulses having a duty cycle corresponding to said proportion of incident radiation that is reflected and places the modulation element in said higher state of reflectivity during each said pulse and in said lower state of reflectivity in the intervals between said pulses.

51. The device of claim 1 wherein said characteristic comprises emission of electromagnetic radiation in the visible spectrum.

52. The device of claim 51 wherein said characteristic comprises the amount of electromagnetic radiation in the visible spectrum that is emitted, on average, by said antennas.

53. The device of claim 1 wherein said characteristic comprises incident electromagnetic radiation in the visible spectrum.

54. The device of claim 1 wherein each said modulation elements comprises three sub-elements each associated with one of three colors of the visible spectrum.

55. The device of claim 1 wherein the optical response in a given modulation state comprises the responses shown in Figures 22G through 22AF.

56. The device of claim 49 wherein said modulation element is responsive to a particular electrical condition to occupy either a state of higher transmissivity or a state of lower transmissivity, and said control circuitry generates a stream of pulses having a duty cycle corresponding to said proportion of incident radiation that is transmitted and places the modulation element in said higher state of transmissivity

during each said pulse and in said lower state of transmissivity in the intervals between said pulses.

57. The device of claim 50 wherein said characteristic comprises the proportion of incident electromagnetic radiation of a given frequency band that is, on average, transmitted by each of said modulation elements.

58. The device of claim 1 wherein said visible spectrum includes ultraviolet frequencies.

59. The device of claim 1 wherein said visible light includes infrared frequencies.

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